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Exploring the Causality Relationship Between Cryptocurrency Market and Islamic Stock Returns: A Toda-Yamamoto Approach

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Abstract

In recent times, this emerging debate between digital assets and traditional Islamic finance underscores the need for a comprehensive investigation of both markets. Thus, in an attempt to highlight the importance of understanding the unique dynamics between different cryptocurrency assets and the cultural and ethical considerations that shape investment decisions within the Islamic finance context, this paper empirically examined the causal linkages of Islamic stock returns in consideration of the Dow Jones Islamic Market World Index, with the cryptocurrency market demands. The Toda-Yamamoto Granger causality tests were applied to daily time-series data from January 2014 to October 2024. The study documents unidirectional causality running from the Solana market to Islamic stock returns. Not surprisingly, the study found no causal relationship between the other sampled cryptocurrency assets and Islamic stock market returns. The results indicated a weak, negligible association between cryptocurrencies and Islamic stock returns, reinforcing the idea that cryptocurrencies do not exert a causal influence on Islamic stocks. This means that movements in the cryptocurrency market do not translate into changes in Islamic stock prices. It is recommended that Islamic investors and general stakeholders maintain a focus on ethical, stable investments, thereby reinforcing the integrity of Islamic finance principles.

Keywords: Cryptocurrency; Islamic Stock Returns; Bitcoin; Shariah; Faith-Based Investments; Toda-Yamamoto

1. Introduction

The connection between the modern-day cryptocurrency influx and Islamic stock market returns has, over the past few decades, increasingly drawn the attention of concerned stakeholders, including academics, policymakers, and, particularly, halal investors. This is because, in recent times, the significance of cryptocurrencies within the broader financial ecosystem has increased, driven by heightened investor interest in their emergence as high-yield investment products (Ahmed, 2021; Alabi, 2025; Ashraf et al., 2023). With a total market capitalisation of around $2.43 trillion, the proliferation of cryptocurrencies prompts researchers to explore their relationship with other financial assets (Mansour et al., 2024). This growth further raises essential questions about the stability of established financial systems, particularly given the decentralised nature of cryptocurrencies, which can pose risks to household wealth and economic activity (Veerasingam et al., 2023). As cryptocurrencies like Bitcoin, Ethereum, among others, gain traction as an alternative investment vehicle, faith-based investors

are keen to understand how these digital assets interact with traditional markets, particularly those that adhere to Islamic finance principles (Bisi & Zreg, 2025; Mansour et al., 2024; Mensi et al., 2020).

Some studies, such as those by Ahmed (2021) and Mensi et al. (2020), indicate spillover effects between the cryptocurrency market and traditional Islamic stock markets, suggesting that movements in cryptocurrency prices can influence Islamic stock market performance and vice versa. This interconnectedness may, however, stem from shared investor sentiment, in which trends in one market can drive trading behaviour in the other, creating a ripple effect that shapes overall market dynamics. However, cryptocurrencies are often perceived as speculative and volatile, which may not align with the principles of Islamic finance, which are guided by strict adherence to Shariah principles (Bossman et al., 2024). Shariah law is generally known for prohibiting activities involving riba (interest), maysir (gambling), and excessive uncertainty (Liizzah et al., 2023). Moreover, some Islamic scholars argue that cryptocurrencies do not fulfil the traditional requirements for currency in Islam and therefore classify them as haram (forbidden) (Munawar & Tariq, 2023). This viewpoint is based on various Shariah guidelines that define acceptable forms of currency (Rahmani & Avdukic, 2022). Amalin (2018) also noted that trading cryptocurrencies has been labelled haram due to their speculative nature and lack of intrinsic value. This ethical stance may lead halal investors to avoid cryptocurrency investments altogether (Mansour et al., 2024; Trichilli & Boujelbéne, 2023). Consequently, if a significant portion of Islamic stock market participants avoid cryptocurrencies, the cryptocurrency market could have little to no impact on Islamic stock indices.

Moreover, Islamic investors often prioritise stability and ethical considerations over high-risk, high-reward investments (Alam et al., 2017; Barom, 2019; Liizzah et al., 2023). The inherent volatility of cryptocurrencies may deter these investors, who might instead seek refuge in more stable Islamic equities. This risk-averse behaviour suggests that fluctuations in cryptocurrency prices are unlikely to influence the performance of Islamic stocks, as Islamic investors may be less likely to react to cryptocurrency market trends due to their aversion to speculative investments. In addition, the cryptocurrency market and Islamic stock indices operate within different frameworks and investor bases. Islamic stock indices typically comprise companies that comply with Shariah principles, whereas cryptocurrencies appeal to a broader audience, often focused on profit maximisation without regard for ethical considerations (Ahmed, 2021; Sami & Abdallah, 2021). Therefore, it is expected that the perception of cryptocurrencies as haram among many within the Islamic community creates a barrier to engagement with the cryptocurrency market. This is because if religious beliefs dictate that cryptocurrencies are not permissible investments, it could lead to a lack of interest or involvement from Islamic investors, thereby minimising any potential impact on Islamic stock indices.

On the other hand, cryptocurrency demand and Islamic stock market performance could influence each other, as suggested by Mensi et al. (2020) and Sami and Abdallah (2021), investor sentiment, economic factors, and market trends may affect both markets similarly, leading to correlated movements. This implies that if cryptocurrencies and Islamic stocks are positively correlated, diversifying between the two might not provide the risk reduction typically sought in a diversified strategy. Conversely, if both exhibit a negative correlation, investors might benefit from including both asset classes to hedge against market volatility. Since cryptocurrencies are known for their volatility, significant price swings could shift market focus, prompting investors to reallocate capital based on perceived risks and rewards, thereby impacting Islamic stock performance (Razak et al., 2024; Wasiuzzaman et al., 2023).

On this premise, the implications of integrating cryptocurrencies into Islamic portfolios necessitate careful consideration, and an evaluation of the causal relationships between cryptocurrency markets and Islamic stock returns is deemed essential. This is also vital for understanding how investors can manage risk and optimise their portfolios by incorporating or not incorporating cryptocurrencies alongside Islamic equities. While the existing literature provides valuable insights, a clear gap remains in the direct assessment of causal linkages between major cryptocurrencies and global Islamic stock returns. Previous studies, such as Mansour et al. (2024), have focused on regional analysis (e.g., GCC countries) or correlation and spill-over effects (e.g., Trichilli & Boujelbéne, 2023; Mensi et al., 2020), often without employing a rigorous causality framework. Therefore, the primary novelty of this study is its application of the Toda-Yamamoto causality test to a global Islamic index (Dow Jones Islamic Market World Index) and the top five cryptocurrencies by market capitalisation, to explicitly determine the direction and existence of causality. This approach allows us to move beyond correlation and directly test whether past values of one

variable help predict another, thereby addressing a critical gap in understanding the dynamic lead-lag relationships between these distinct asset classes. While the general absence of causality may align with theoretical assumptions regarding the ethical and operational separation of these markets, this study provides crucial global-scale empirical validation by analysing the causal relationship between the cryptocurrency market and Islamic stock returns.

This study, therefore, raises two explicit research questions (RQ):

RQ1: Does past information in leading cryptocurrencies (Bitcoin, Ethereum, Tether, Binance Coin and Solana) Granger-cause global Islamic stock returns?

RQ2: Is any detected causality asset-specific (i.e., do cryptocurrencies exhibit directional causality with Islamic stock returns while others do not)?

In essence, this study fills an empirical gap by applying the Toda–Yamamoto causality procedure to daily data on the Dow Jones Islamic Market World Index and five leading cryptocurrencies, offering a pre-test-free, VAR-in-levels test of directional causality that provides asset-specific evidence on crypto–Islamic equity linkages and thereby informs both Shariah-conscious portfolio decisions and regulatory assessment of crypto spillovers into faith-based markets.

The rest of the study is organised as follows: the second section covers the relevant literature in the current study's domain. The third section presents the methodology used in the study, the following section discusses the findings and empirical results, and the last section concludes the study.

2. Literature Review

2.1. Growth, Risks, and Systemic Implications of Cryptocurrencies

The rapid rise of cryptocurrency assets, along with their vulnerabilities and growing integration into traditional financial institutions, has raised substantial concerns in financial markets. As noted by Bossman et al. (2024), this can lead to increased systemic risks that could undermine established financial systems. The unique characteristics of cryptocurrencies, such as their high volatility and lack of regulatory oversight, can amplify these vulnerabilities, making it vital for stakeholders to recognise and address these specific challenges (Al-Guindy, 2021; Fang et al., 2020).

In response to these issues, Bhatnagar et al. (2023) emphasise the importance of developing effective strategies to mitigate risks associated with cryptocurrencies while fostering sustainable economic growth. This dual approach is vital for maintaining balance within the rapidly evolving digital finance landscape. Without proactive measures, the integration of crypto assets could lead to unforeseen consequences that threaten both individual investors and the broader economy (Badlani et al., 2023; Benetton & Compiani, 2024). Additionally, enhancing financial literacy among investors can help them make informed decisions, reducing the likelihood of significant losses due to market volatility (Sami & Abdallah, 2021).

2.2. Interactions Between Cryptocurrency and Islamic Stock Markets

Extant studies on the impact of cryptocurrencies on Islamic stock markets are limited. Mansour et al. (2024) examined whether the effects of the cryptocurrency market on Islamic versus conventional stock markets differ across the GCC region and how these effects have changed since the cryptocurrency crash. The study found that cryptocurrency returns negatively affected both Islamic and conventional stock market returns in the GCC, with the effect more pronounced for conventional stocks.

During the two periods analysed (before and after the crash), the cryptocurrency market remained negatively correlated with conventional GCC stocks, while it became uncorrelated with GCC Islamic stocks. Similarly, Trichilli and Boujelbéne (2023) suggested that contagion dynamics (how changes in one market affect others) depend on whether markets are in bullish or bearish trends. Using a Markov-switching model, they found distinct spill-over patterns

among the Dow Jones Islamic Market World Index, Islamic gold-backed cryptocurrencies, and the halal chain, especially during the COVID-19 pandemic. These findings highlight that the interrelationships between cryptocurrencies and Islamic financial instruments shift with market sentiment and volatility.

To address the evolving understanding of crypto–equity interlinkages, this study further acknowledges that dynamic connectedness and volatility transmission analyses, such as Diebold–Yilmaz spillover indices and time-varying parameter VAR models, have provided richer evidence on how shocks in cryptocurrency markets propagate into equities (e.g., Corbet et al., 2018; Umar & Gubareva, 2020). Dynamic conditional correlation and wavelet-based frameworks (e.g., Bouri et al., 2021) reveal that spillovers intensify during crisis periods such as the COVID-19 pandemic, suggesting that crypto–Islamic stock linkages may themselves be regime-dependent.

2.3. Co-movements, Portfolio Diversification, and Hedging Potential

The co-movement between Bitcoin (BTC) and various financial markets, including the Dow Jones World Stock Market Index, regional Islamic stock markets, and Sukuk markets, has also attracted attention. Mensi et al. (2020) revealed that BTC and these markets tend to move together at lower frequencies, implying limited long-term diversification benefits. Similarly, Sami and Abdallah (2021) found a significant relationship between cryptocurrency movements and stock market performance in the MENA region, underlining the interconnectedness of these markets.

Recent studies have also documented asymmetric and nonlinear return spillovers between crypto assets and Islamic indices, highlighting that the relationship may vary across bullish and bearish regimes (Umar et al., 2022; Naeem et al., 2023). Such findings justify examining the stability of causality across sub-samples or volatility phases. This paper acknowledges this issue as an area for future research. Bányai et al. (2024) further noted that cryptocurrencies can serve as hedges against stock market risks, supporting Yao et al.'s (2024) argument that they should be considered a separate asset class. These insights suggest that cryptocurrencies could play a complementary role in investment portfolios. Wasiuzzaman et al. (2023) also emphasise that the differing business cycles of cryptocurrencies and traditional assets can mitigate risk when combined.

2.4. Theoretical and Behavioural Perspectives on Cryptocurrency–Islamic Stock Linkages

Several theoretical frameworks have been applied to understand how cryptocurrency trading relates to stock market performance. Veerasingam et al. (2023) employed the theory of planned behaviour to examine how investor attitudes and technological mediation shape cryptocurrency investments in Islamic emerging markets. Similarly, Surtee & Alagidede (2023) drew on modern portfolio theory, which provides strategies for balancing risk and return while considering subjective preferences and time horizons.

From an Islamic finance standpoint, Islamic stocks possess distinctive characteristics that enhance their appeal for diversification with cryptocurrencies such as Bitcoin and Ethereum. However, Muslim investors' attitudes toward cryptocurrencies (driven by concerns about volatility and the speculative nature of these assets) may limit their participation in crypto markets (Mansour et al., 2024; Munawar & Tariq, 2023; Razak et al., 2024; Wasiuzzaman et al., 2023). Consequently, slower adoption in Muslim-majority economies is attributable to challenges with Shari'ah compliance (Ismail et al., 2025; Issa et al., 2025).

Moreover, behavioural theories such as information diffusion and investor conservatism have been used to explain how cryptocurrency price movements affect other asset classes (Yadav, 2024). Nonetheless, the unique characteristics of Islamic finance, such as risk aversion (the avoidance of excessive uncertainty or "gharar") and ethical considerations, shape investor behaviour. Supporting this view, Luo et al. (2024) and Nguyen and Nguyen (2024) show that behavioural dynamics influence how cryptocurrencies interact with conventional stock markets. This framework, therefore, limits the speculative behaviour common in many cryptocurrency markets, yet there is potential for some digital assets, such as Solana, to affect Islamic stock returns due to the technological and sectoral innovations they represent. Specifically, Solana's unique ecosystem, driven by its scalability and low transaction costs, appeals to investors in sectors that align with Shariah-compliant technology. This creates

a possible link to Islamic stocks that are similarly positioned within technological sectors, demonstrating that certain cryptocurrencies may exhibit causality with Islamic equities through technological sectoral spillovers, rather than mere speculation or volatility (Bányai et al., 2024; Wasiuzzaman et al., 2023).

2.5. Methodological Considerations and Chosen Approach

A review of the extant literature reveals several methodological approaches to studying market interconnectedness. Studies such as Mensi et al. (2020) and Trichilli & Boujelbéne (2023) have effectively utilised wavelet coherence analysis to uncover frequency-dependent and time-varying co-movements. Others, including Sami & Abdallah (2021), have relied on VAR models and standard Granger causality tests. While wavelet analysis is excellent for revealing the intensity and phase of correlations across different investment horizons, it is less direct in establishing causality through statistical testing. The standard Granger causality test, on the other hand, requires all time series to be stationary or cointegrated, a condition that often necessitates pre-testing and transformation, which can introduce bias.

This study employs the Toda-Yamamoto (1995) causality procedure to address these limitations. Its primary advantage lies in its ability to test for causality between variables, regardless of their integration order or the presence of cointegration. By fitting a VAR model in levels with an augmented lag length (k + dmax), it avoids the potential pre-test biases associated with unit root and cointegration tests (Tekin & Yener, 2019). This makes it a particularly robust and reliable method for establishing the direction of influence, which is a central aim of this paper.

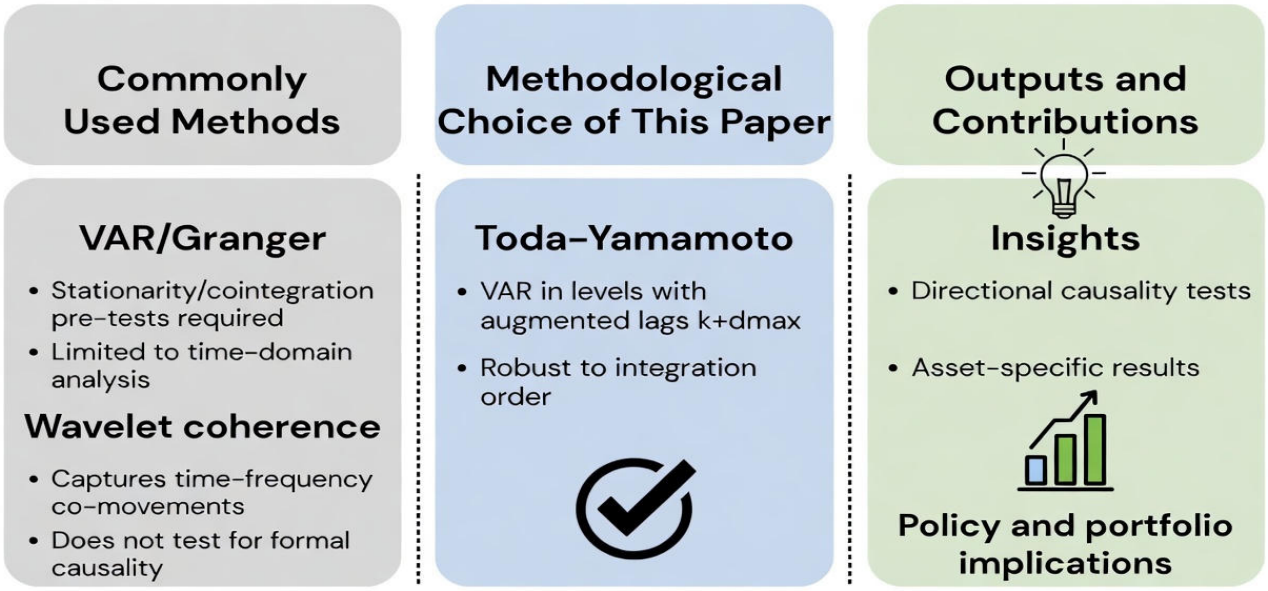
Although the Toda–Yamamoto procedure is linear in structure, its selection remains appropriate for this study because it offers strong finite-sample reliability, eliminates pre-test bias, and performs consistently regardless of the integration properties of the variables. This is an important advantage given the mixed orders of integration typically observed in cryptocurrency data. While cryptocurrency returns indeed exhibit pronounced nonlinearity, volatility clustering, and regime shifts, linear causality tests such as the Toda–Yamamoto are still widely accepted as a first-stage, model-free diagnostic framework for establishing baseline directional predictability. Moreover, given the heterogeneity of empirical methods in the crypto-finance literature, this paper complements prior dynamic connectedness, volatility-spillover, and nonlinear causality studies by adopting a baseline Toda–Yamamoto causality test as a pre-test-free benchmark. This positioning bridges traditional linear frameworks with the evolving spectrum of nonlinear and time-varying models, providing a reference point for subsequent comparative analysis. Nonetheless, we acknowledge that the complex behaviour of digital assets may require complementary approaches. Therefore, while not entirely novel in a broad sense, Toda-Yamamoto's application to this specific asset-class pairing provides a more rigorous test of causality than has been commonly applied, offering a clearer and more statistically sound answer to the question of 'does A cause B?'.

In theoretical terms, the causal relationship between Islamic equities and cryptocurrencies can be driven by behavioural and structural mechanisms. On one hand, Islamic equity investors are indirectly exposed to technological sentiment and speculative waves originating from digital asset markets. On the other hand, faith-based market segmentation and Shariah-compliance screening attenuate direct spillovers, creating partial but asymmetric transmission channels. This conceptual duality provides an economic rationale for testing directional predictability between these two asset classes.

Nevertheless, the literature shows that crypto–equity relationships are not static but time-varying, often exhibiting shifts across bull and bear cycles or during systemic crises. Therefore, while the Toda–Yamamoto procedure provides a stable baseline test free from pre-test bias, we acknowledge its limitation in capturing structural breaks or evolving causal dynamics over time. To partially address this, we examined alternative lag lengths (up to k = 5) and verified that results were robust to these variations. In addition, we performed a structural break check using the Bai–Perron (Bai & Perron, 2003) multiple breakpoint test to confirm the stability of the estimated parameters.

Figure 1 contrasts the principal methodological alternatives used in the literature (classical VAR/Granger and wavelet coherence) with the Toda–Yamamoto procedure employed here, highlighting the latter's advantage of testing for causality without pre-test bias across series with different degrees of integration.

Figure 1. Conceptual schematic contrasting common approaches and the Toda–Yamamoto procedure used in this study



Source: Authors' elaboration

3. Methodology

The study's methodological design is anchored in the theoretical proposition that, if present, causality arises through investor sentiment channels, portfolio rebalancing mechanisms, and technological spillovers between decentralised digital assets and Shariah-compliant equities. The study, therefore, explored the relationship between cryptocurrency market demand and returns on Islamic stocks, using the methodology developed by Toda and Yamamoto (1995).

Given data availability, the study focused on the daily prices of the five leading cryptocurrencies by market capitalisation (as shown in Table 1). This includes Bitcoin (BTC) from 30th September 2014, Ethereum (ETH) from 10th March 2016, Tether USDt (USDT) from 15th April 2017, Binance Coin (BNB) from 9th November 2017, and Solana (SOL) from 20th July 2020. This selection criterion was adopted to ensure the inclusion of assets with the highest economic significance, liquidity, and influence within the global crypto market (Alabi, 2025). These leading assets collectively represent a substantial portion of the entire cryptocurrency market and are most likely to exhibit, or lack, systemic relationships with other major financial markets, such as Islamic stocks.

Table 1. Top five leading cryptocurrencies by market capitalisation

S/N	Symbol	Name	Price	Market Cap	Total Volume
1	BTC	Bitcoin	$65,629.3	$1.30T	45.15%
2	ETH	Ethereum	$2,611.29	$314.13B	21.86%
3	USDT	Tether USDt	$0.9996	$119.68B	77.33%
4	BNB	Binance Coin	$587.17	$85.61B	1.94%
5	SOL	Solana	$154.432	$72.58B	2.99%

Source: Investing.com (https://investing.com), accessed October 2024.

The study also used the daily price returns of the Dow Jones Islamic Market World Index as a key indicator for Islamic stock returns from 30th September 2014 to 15th October 2024. The Dow Jones Islamic Market World Index was selected as the proxy for Islamic stock returns due to its comprehensive, globally diversified nature, offering a broad perspective beyond regional constraints. These variables were therefore identified as the primary ones for analysing their causal relationship. Data on the cryptocurrency variables were obtained from investing.com, while information on Islamic stock returns was extracted from S&P Dow Jones Indices LLC reports detailing the performance of Islamic stocks and reflecting Shariah-compliant equity investments (S&P Dow Jones Indices, 2024). To enhance understanding and interpretation, the data variables were transformed logarithmically. Figure 2 presents logarithmic representations that illustrate trends in these variables.

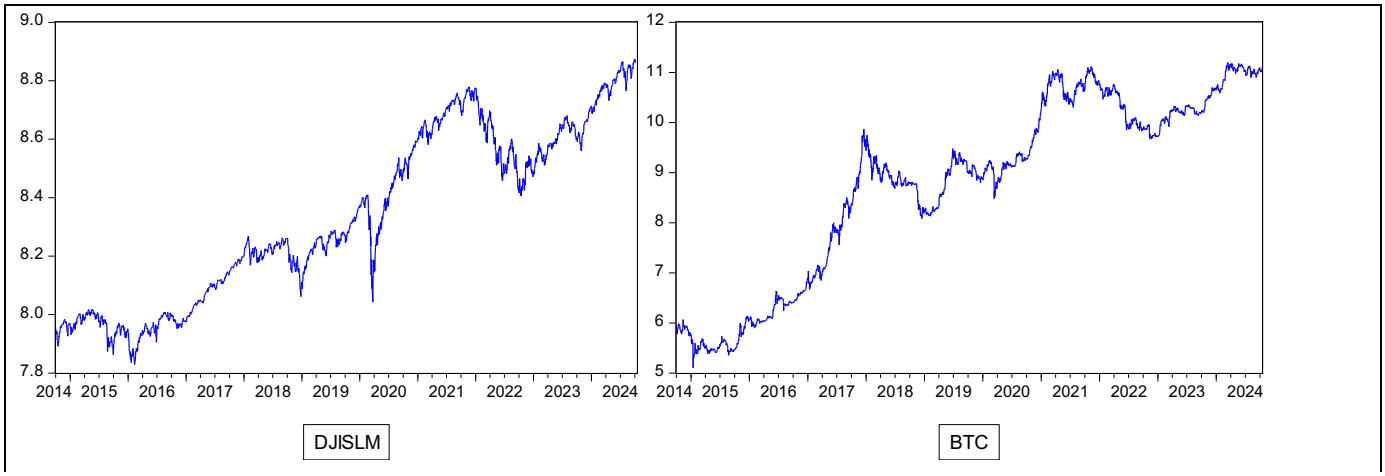
Table 2 reveals that while Islamic stock returns (DJISLM) are relatively stable, cryptocurrencies proxied with (BTC, ETH, USDT, BNB, and SOL) exhibit high volatility and potential for greater returns. The relatively stable mean of DJISLM (8.3348) and low standard deviation (0.2936) contrast with the high volatility and return potential observed across all cryptocurrency variables**.** BTC stands out with the highest mean return (8.7737) and significant volatility (standard deviation of 1.8051), suggesting a possible impact on Islamic stock returns. ETH also shows considerable average returns, while USDT remains stable as a low variation stablecoin.

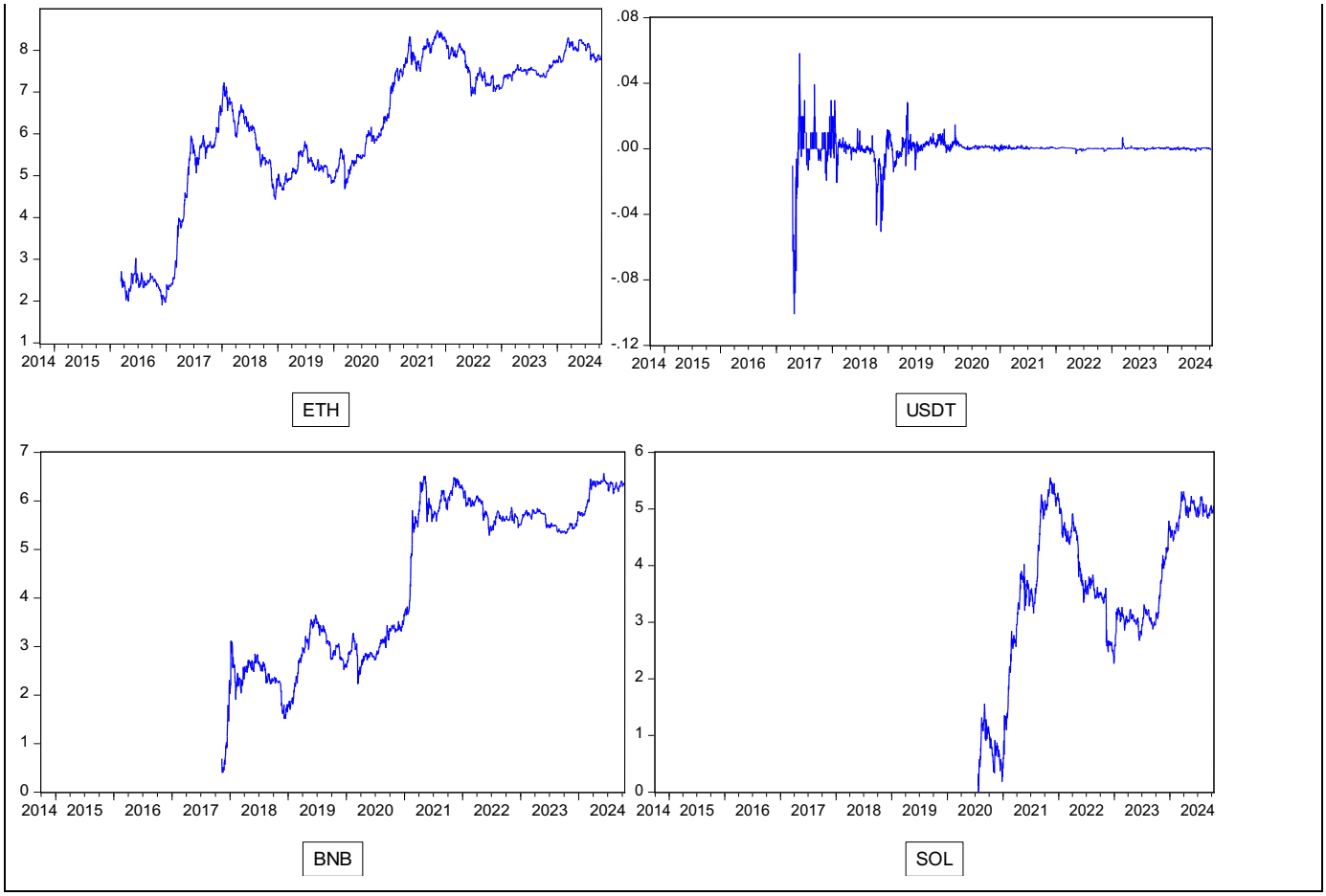
Table 2. Descriptive Statistics

Identifiers	**DJISLM**	**BTC**	**ETH**	**USDT**	**BNB**	**SOL**
Mean	8.3348	8.7737	6.1212	-0.0001	4.3865	3.5504
Median	8.2733	9.1302	6.3048	0.0002	5.3849	3.5551
Maximum	8.8836	11.1991	8.4781	0.0583	6.5669	5.5548
Minimum	7.8290	5.1053	1.9021	-0.1009	0.3988	0.0040
Std Dev	0.2936	1.8051	1.7642	0.0085	1.6449	1.3435
Observations	3144	3669	3142	2741	2533	1549

Source: Authors' elaboration

Figure 2. Logarithmic trends of the Islamic stock index and cryptocurrency prices





Source: Authors' elaboration

This further implies that the strong performance of BTC and ETH may influence Islamic stock returns, warranting further investigation into the causal relationships. Additionally, the stable nature of USDT as a benchmark could serve as a point of comparison for evaluating the effects of cryptocurrency volatility on Islamic stock returns. For this reason, the study proceeded to the causality testing, which is expected to be beneficial in understanding the relationships more deeply.

The analysis further employed the causality test formulated by Toda and Yamamoto (1995). The Toda-Yamamoto (1995) causality test was selected for this study due to its significant methodological advantages over the standard Granger causality test (Alabi & Ishola, 2025). A key limitation of the standard test is its requirement for all variables to be stationary or cointegrated of the same order. The Toda-Yamamoto procedure overcomes this by employing a Modified Wald test on a VAR model augmented with extra lags (k + dmax). This robust feature allows for reliable causality testing irrespective of the variables' integration order or the presence of cointegration, thereby eliminating pre-test bias and ensuring the validity of our inferences (Tekin & Yener, 2019). The technique follows a strategic progression. To evaluate the significance of parameters in the vector autoregressive (VAR(k)) model, the Modified Wald statistic is a valuable tool that links multiple time points. To begin, the maximum order of integration (dmax) for the time series was determined, followed by the detection of the optimal lag length (k) for the VAR model. Once these values are known, a VAR model of order (k + dmax) is estimated, ensuring that the Wald statistic adheres to an asymptotic Chi-square distribution. Finally, hypothesis testing is carried out using a standard Wald statistic test, which follows a chi-square distribution with m degrees of freedom. The formulas for the Toda and Yamamoto (1995) causality test are presented as follows:

$$LnYt = \alpha_0 + \sum_{i-1}^{k} \alpha i \; LnYt - 1 + \sum_{j-k+1}^{dmax} \alpha j \; LnYt - j + \sum_{i-1}^{k} \emptyset_i \; LnX_{t-1} + \sum_{j-k+1}^{dmax} \emptyset_j \; LnX_{t-j} + v_{1t} \quad \text{(eq1)}$$

$$LnXt = \beta_0 + \sum_{i-1}^{k} \beta i\ LnXt - 1 + \sum_{j-k+1}^{dmax} \beta j\ LnXt - j + \sum_{i-1}^{k} \infty_i\ LnY_{t-1} + \sum_{j-k+1}^{dmax} \infty_j\ LnY_{t-j} + v_{2t} \quad \text{(eq2)}$$

In this study, LnY and LnX denote the logarithmic variables representing Islamic stock index returns (DJISLM), BTC, ETH, USDT, BNB, and SOL, respectively. The parameter k indicates the optimal lag order, whereas d denotes the maximum integration order of the sequence. Additionally, v1t and v2t represent the error terms unified in the equations.

4. Results and Discussions

Assessing causal relationships among variables is crucial in econometric analyses, and this requires the use of various methodologies to reduce the risk of misleading results. A critical step in conducting a causality test is determining the order of integration (dmax) and identifying the appropriate lag length (k + dmax).

The study began with the ADF Dickey-Fuller unit root test, followed by a confirmatory test using the Phillips-Perron method to determine the highest order of integration. The results presented in Table 3 detail the outcomes of the two unit root tests, which showed non-stationarity in both the intercept and trend-and-intercept forms at the level. However, all variables were stationary when examined at first differences. This state of stationarity indicates that the variables are integrated of order 1 (I(1)). As a result, the maximum order of integration for the system's variables is 1, or $d_{max} = 1$. Additionally, the PP unit root test results confirmed that all variables were stationary at first differences.

Table 3. Augmented Dickey–Fuller and Phillips–Perron unit root tests

Augmented Dickey-Fuller (ADF)						
Level						
Levels	DJISLM	BTC	ETH	USDT	BNB	SOL
t-statistic	0.321027	-0.341083	-1.451688	-11.46824	-0.992994	-1.346965
Prob.	0.9792	0.9164	0.5582	0.000***	0.7578	0.6094
At first difference						
Levels	DJISLM	BTC	ETH	USDT	BNB	SOL
t-statistic	-12.4983	-63.71739	-60.03128	-20.44076	-23.61722	-39.68642
Prob.	0.000***	0.0001***	0.0001***	0.000***	0.000***	0.000***
Phillips-Perron (PP)						
Level						
Levels	DJISLM	BTC	ETH	USDT	BNB	SOL
t-statistic	-0.35054	-0.449362	-1.50702	-13.7528	-1.090797	-1.408321
Prob.	0.9149	0.8983	0.5301	0.000***	0.7216	0.5796
At first difference						
Levels	DJISLM	BTC	ETH	USDT	BNB	SOL
t-statistic	-46.9291	-63.63995	-59.93722	-77.75935	-56.38621	-39.68918
Prob.	0.0001***	0.0001***	0.0001***	0.000***	0.0001***	0.000***

Source: Authors' elaboration.

(**) Significant at the 5%; ***(***) Significant at the 1%; (no) Not Significant***

The next step is selecting the lag order to identify the optimal lag length. A VAR model was created using all endogenous variables and a randomly chosen lag interval. Afterwards, a test was conducted on the residuals to determine the best lag length based on several criteria, including LogL (Log-Likelihood), LR (Likelihood Ratio), FPE (Final Prediction Error), AIC (Akaike Information Criterion), SC (Schwarz Criterion), and HQ (Hannan-Quinn Criterion). Each criterion has its own advantages and drawbacks, influencing the chosen lag order. An asterisk (*) indicates the lowest value in each category, signifying the optimal lag for that specific criterion.

Table 4. VAR lag order selection

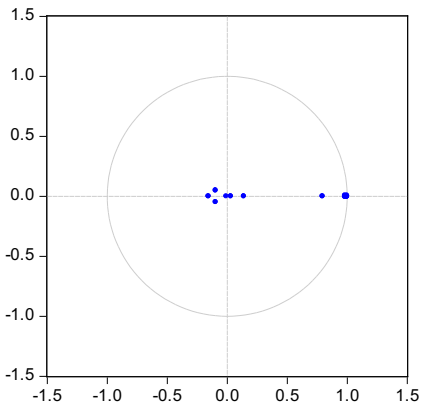
Lag	LogL	LR	FPE	AIC	SC	HQ
0	1241.34	NA	5.34E-13	-11.23038	-11.13783	-11.193
1	3810.48	4974.794	5.33E-23	-34.25895	-33.61107*	-33.99732*
2	3864.88	102.3647	4.51E-23	-34.42619	-33.223	-33.94031
3	3911.41	85.02628*	4.11e-23*	-34.52194*	-32.76342	-33.8118
4	3925.91	25.6985	5.01E-23	-34.32645	-32.01261	-33.39206
5	3950.56	42.34553	5.59E-23	-34.22323	-31.35407	-33.06459

*Source: Authors' elaboration [*indicates lag order selection by the criterion]*

Table 4 shows the optimal lag lengths, marked with an asterisk (*). The Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ) indicate a lag length of 1, while the sequentially modified LR test statistic, final prediction error (FPE), and Akaike information criterion (AIC) suggest a lag length of 3. Since the criterion with the most asterisks (*) indicates the best lag length, the study thus established the optimal lag length for the VAR system to be k = 3. Hence, the k + dmax = 3 + 1 = 4.

Additionally, Figure 3 illustrates the stability condition for an autoregressive (AR) model, confirming that all inverse roots of the AR characteristic polynomial lie within the unit circle, the standard condition for VAR stability. This confirms that the model is dynamically stable and that the AR characteristic polynomial lies within the unit circle, highlighting the significance of this condition for a valid analysis of the model's results.

Figure 3. Inverse roots of the AR characteristic polynomial



Source: Authors' elaboration

To conclude the analysis, Table 5 presents the results of the Toda-Yamamoto causality test. These results show that, at the conventional significance level, there is no causal connection between Islamic stock market returns and the sampled cryptocurrencies, except for Solana, which showed significance at the 5% level. This suggests that fluctuations in cryptocurrency prices, particularly for Bitcoin, Ethereum, Tether, and Binance Coin, neither cause nor significantly influence the returns of Islamic stocks. This result is consistent with the theory of planned behaviour and aligns with the findings of Razak et al. (2024), Veerasingam et al. (2023), and Wasiuzzaman et al. (2023). This lack of causality could imply that Islamic stock market investors are not responding to movements in the cryptocurrency market, reflecting distinct investment philosophies and risk appetites in each market. In addition, this outcome also aligns with the evidence reported by Mansour et al. (2024) and Trichilli and Boujelbéne (2023), who found that cryptocurrency markets often exhibit weak or insignificant linkages with Islamic financial instruments under normal conditions. Their results similarly showed that during calmer periods, Islamic stocks tend to be independent of cryptocurrency price fluctuations. Hence, the non-causality observed in this study reinforces the notion that Islamic stocks and most cryptocurrencies remain segmented markets driven by different investor motivations and regulatory frameworks.

Comparatively, the results further revealed that Solana affects Islamic stock market returns, but not vice versa, indicating unidirectional causality. This implies that Solana has a one-way effect on Islamic stock market returns, meaning that changes in Solana's prices and overall demand directly affect Islamic stock returns, but not vice versa. From an economic perspective, this could suggest that causality runs from Solana to Islamic stock returns, indicating a level of integration in which investors in Islamic stocks are influenced by Solana's performance. This could reflect broader market trends in which innovative or high-performing cryptocurrencies attract investor attention, potentially leading them to reallocate funds into related stocks in response to Solana's price movements. While the general lack of causality across other cryptocurrencies aligns with the theoretical separation argued by scholars such as Munawar and Tariq (2023) and Mansour et al. (2024), Solana's behaviour presents a clear exception. We posit that this is not random but can be explained by its unique characteristics within the crypto asset class.

Unlike Bitcoin, which is primarily a "store-of-value" or digital gold, and Ethereum, a decentralised general-purpose computer, Solana has positioned itself as a high-performance blockchain optimised for scalability and low transaction costs. This technological differentiation has fostered an ecosystem heavily concentrated in decentralised finance (DeFi) and non-fungible tokens (NFTs), areas synonymous with technological innovation and growth. This aligns with the concept of sectoral sentiment spill-over (Bossman et al., 2024). The Dow Jones Islamic Market World Index, while Shariah-compliant, has a significant weighting in the Technology sector (S&P Dow Jones Indices, 2024). Positive momentum and innovation in the Solana ecosystem could therefore boost overall investor confidence in the technology sector, indirectly benefiting Shariah-compliant tech stocks within the index. This creates a channel of influence that is less relevant for Bitcoin (a monetary asset) or Tether (a stablecoin).

This finding resonates with the arguments of Wasiuzzaman et al. (2023) and Bányai et al. (2024), who suggest that cryptocurrencies possess unique characteristics and business cycles. Our results extend this by showing that these characteristics are not uniform; they are asset-specific. Therefore, in this context, Solana may not function as a generic crypto asset but rather as a proxy for a specific theme of technological innovation, whose sentiment spills over into related equity sectors. This nuance is critical, indicating that a granular, asset-specific analysis is necessary when assessing the interplay between digital assets and Islamic finance, moving beyond the homogenous treatment often seen in the literature.

Table 5. Toda-Yamamoto Granger causality test results

Dependent variable: DJISLM			Dependent variable: BTC			Dependent variable: ETH		
Excluded	**Chi-sq**	**Prob.**	**Excluded**	**Chi-sq**	**Prob.**	**Excluded**	**Chi-sq**	**Prob.**
BTC	4.136	0.247	DJISLM	0.582	0.901	DJISLM	0.757	0.860
ETH	1.075	0.783	ETH	9.011	0.029*	BTC	5.484	0.140
USDT	2.276	0.517	USDT	2.438	0.487	USDT	0.435	0.933
BNB	5.705	0.127	BNB	5.251	0.154	BNB	1.739	0.628
SOL	7.850	0.049*	SOL	2.638	0.451	SOL	0.492	0.921
All	19.373	0.197	All	20.209	0.164	All	9.560	0.847
Dependent variable: USDT			Dependent variable: BNB			Dependent variable: SOL		
Excluded	**Chi-sq**	**Prob.**	**Excluded**	**Chi-sq**	**Prob.**	**Excluded**	**Chi-sq**	**Prob.**
DJISLM	3.691	0.297	DJISLM	2.748	0.432	DJISLM	0.098	0.992
BTC	1.959	0.581	BTC	1.788	0.618	BTC	1.349	0.718
ETH	1.911	0.591	ETH	1.511	0.680	ETH	7.210	0.066
BNB	4.078	0.253	USDT	0.407	0.939	USDT	1.248	0.742
SOL	3.319	0.345	SOL	4.329	0.228	BNB	7.304	0.063
All	18.747	0.225	All	19.735	0.182	All	28.505	0.019*

d_{max}	1
Lag	3
$K+d_{max}$	4

Source: Authors' elaboration

**Statistical significance at the 5% level*

Furthermore, the absence of a causal relationship between Islamic stock returns and most sampled cryptocurrencies can again be understood through the lens of Islamic finance principles, particularly the notion of halal (permissible) and haram (forbidden) investments. Drawing on the established view that many halal-conscious Muslims regard cryptocurrencies as haram due to concerns about speculation, high volatility, and the lack of intrinsic value or tangible backing. Furthermore, cryptocurrencies are notorious for their high volatility and speculative nature, which can deter conservative investors, including those adhering to Islamic finance principles. Islamic stock investors may be more risk-averse and prefer investments aligned with Shariah-compliant principles, emphasising long-term growth and stability. This inherent risk aversion means that even if cryptocurrency markets experience significant price movements, they may not affect the Islamic stock market, as investors remain disengaged from speculative, high-risk assets. This interpretation is consistent with the perspectives of Munawar and Tariq (2023), Razak et al. (2024), and Wasiuzzaman et al. (2023), who note that the speculative and uncertain nature of most cryptocurrencies limits their acceptance among Shariah-conscious investors. These findings collectively support the argument that Islamic investors prioritise assets perceived as stable, transparent, and ethically aligned traits that are not widely associated with the broader cryptocurrency market.

In addition, the distinct characteristics of Islamic stocks and cryptocurrencies could imply that they operate in largely separate markets. Islamic stock markets cater to investors looking for Shariah-compliant opportunities, while the cryptocurrency market attracts a different demographic, often drawn by the potential for rapid gains. This segmentation means that market dynamics

in one sector do not necessarily spill over into the other. Thus, fluctuations in cryptocurrency prices are less likely to influence the performance of Islamic stocks, as the latter operate under different principles and investor motivations. This perspective could influence investment behaviour and explains the findings of this study regarding why the cryptocurrency market does not significantly affect Islamic stock returns. This divergence in investment philosophy could have resulted in limited interaction between the two markets. The absence of causality to Islamic equities also aligns with the core Shariah principles that discourage exposure to excessive uncertainty (gharar) and speculative behaviour (maysir). Cryptocurrencies are widely documented as exhibiting high speculative intensity, extreme volatility and leverage-driven price cycles, characteristics that are inconsistent with the prudential guidelines specified by AAOIFI (2020) and the Islamic Financial Services Board.

However, the notable exception among the sampled cryptocurrencies, Solana, exhibits a unidirectional causal relationship with Islamic stock returns and warrants further consideration. It could mean that some Islamic investors are beginning to explore opportunities in the cryptocurrency space, potentially viewing Solana as a more legitimate or innovative option than other cryptocurrencies. This could indicate growing acceptance of certain cryptocurrencies that align more closely with Islamic finance principles, such as technological innovation or community-based projects. This aligns with the observations of Bányai et al. (2024) and Yao et al. (2024), who emphasise that certain digital assets may serve as effective hedges or diversification tools within broader portfolios.

Table 6. Summary of robustness checks

Test Type	Specification	Lag Order / Breakpoint	Causality Outcome	Sig. Level	Inference
Baseline Model (Toda–Yamamoto)	VAR(k+dmax) = VAR(3+1)	k = 3	Solana → DJISLM	5%	Unidirectional causality confirmed (benchmark model)
Lag Robustness Test 1	VAR(k+dmax) = VAR(2+1)	k = 2	Solana → DJISLM	5%	Causality remains statistically significant; results stable at shorter lag length
Lag Robustness Test 2	VAR(k+dmax) = VAR(5+1)	k = 5	Solana → DJISLM	5%	Causality persists across higher lag length; no sensitivity to lag variation
Structural Break Test (Bai–Perron)	Sequential multiple breakpoint F-statistics	Breakpoints = 0 (none detected)	Solana → DJISLM	–	No significant structural breaks; model parameters stable across sample period
Cross-Validation Summary	Comparison of model outcomes across lag and break tests	2014–2024 (Full Sample)	Solana → DJISLM	Robust at 5%	Directional causality is consistent and stable across specifications

Source: Authors' elaboration

To further contextualise the Solana–Islamic stocks causality, a brief comparison of return dynamics across the sampled cryptocurrencies reinforces why Solana behaves differently from Bitcoin and Ethereum. As shown in Table 2, Solana exhibits

notably higher return volatility than Ethereum and Bitcoin, despite its shorter trading history. In practical terms, Solana's price movements show sharper short-term swings, faster trend accelerations, and more abrupt reversals, patterns characteristic of high-throughput blockchain ecosystems. This behaviour is consistent with the design of the Solana network, which relies on its Proof-of-History (PoH) consensus and exceptionally high transaction throughput to support activities such as DeFi lending, staking, automated market makers, and concentrated NFT marketplaces. These technological features anchor Solana's price dynamics more closely to real-time user demand, network congestion, and innovation cycles, thereby amplifying its sensitivity to technology-oriented market sentiment. The implication is that the detected causality may not purely reflect financial integration between cryptocurrencies and Islamic stocks, but rather a broader technological spillover mechanism. Because the Dow Jones Islamic Market World Index maintains significant exposure to technology-oriented Shariah-compliant firms, innovation shocks emanating from fast-evolving blockchain ecosystems (such as those built around Solana) can diffuse into Islamic equities through sectoral sentiment, digital adoption expectations, and investor confidence effects. This interpretation positions Solana not as a generic cryptocurrency but as a proxy for rapid technological evolution, whose influence extends indirectly to Shariah-compliant technology equities. Consequently, Solana's unique characteristics, combining innovation, efficiency, and growing investor confidence, could explain its ability to influence Islamic stock market returns, unlike other cryptocurrencies analysed in this study. From a policy perspective, these findings reinforce the need for Islamic portfolio managers and regulators to distinguish between speculative crypto-market behaviour, which may fall under maysir, and legitimate technological spillovers that indirectly affect the performance of listed Shariah-compliant firms. In line with IFSB and AAOIFI governance expectations, the results suggest that Islamic investment frameworks should continue to maintain a cautious distance from cryptocurrency trading activities, while remaining attentive to technology-driven market signals that may shape sector-level dynamics within Shariah-compliant equity markets.

To ensure the reliability and validity of the baseline findings with respect to the unidirectional causality from Solana to Islamic stock returns, which is the most distinctive finding of this study, we implemented additional robustness checks in Table 6, focusing on alternative lag lengths, structural breaks, and model stability across different specifications. The robustness checks conducted confirm the stability and reliability of the unidirectional causality from Solana to Islamic stock returns. The lag robustness tests, using both shorter (k=2) and longer (k=5) lag lengths, consistently show that the causality remains statistically significant across different timeframes, reinforcing the robustness of the initial finding. Additionally, the structural break test (Bai-Perron) revealed no significant breakpoints, suggesting that the causality relationship is stable and not influenced by major shifts or disruptions in the sample period. The cross-validation summary further supports these findings, with the causality consistently holding across various model specifications. These results align with the study's main findings, confirming that the causal relationship between Solana and Islamic stock returns is both reliable and stable. The lack of sensitivity to lag choices, structural breaks, or model specifications adds credibility to the conclusion that Solana uniquely influences Islamic stock returns, while other cryptocurrencies do not exhibit such causal relationships. These robustness tests, therefore, reinforce the study's core result and ensure that the observed causality is not spurious or driven by external factors. This confirms the robustness of our findings despite market dynamics. These insights are crucial for understanding the role of cryptocurrencies in Islamic portfolios and have practical implications for investors and policymakers.

5. Conclusion

This study investigated the causal relationship between the cryptocurrency market and Islamic stock returns by utilising the daily prices of the five leading cryptocurrencies by market capitalisation (Bitcoin, Ethereum, Tether USDt, Binance Coin, and Solana). The study employed the Toda-Yamamoto causality test to assess the relationships. The findings revealed that, at conventional significance levels, there is no causal connection between Islamic stock returns and most sampled cryptocurrencies, with the notable exception of Solana. Solana demonstrated a unidirectional causal effect on Islamic stock returns, suggesting that fluctuations in its price can influence investor sentiment within the Islamic stock market. This divergence in relationships reflects the distinct investment philosophies driven by Shariah compliance among halal-conscious investors, who typically avoid cryptocurrencies perceived as speculative and high-risk.

The findings of this study offer crucial insights for portfolio diversification, risk management, and investment decision-making within the Islamic finance framework. The lack of causal relationships between most cryptocurrencies and the Dow Jones

Islamic Market World Index suggests that, in general, cryptocurrencies have limited predictive power and diversification potential for Islamic equity portfolios. This implies that integrating cryptocurrencies into Islamic stock portfolios may not significantly alter the risk-return profile for investors, as the movements in cryptocurrency prices do not appear to drive changes in Islamic stock returns. However, the unidirectional causality observed between Solana and Islamic stock returns offers a unique opportunity for portfolio managers and investors. Solana's price movements could serve as an early indicator of broader market trends or shifts, particularly within the technology sector, which is heavily represented in the Islamic index. Investors could consider monitoring Solana's performance and incorporating it into their portfolio strategy as a leading signal for potential reallocation or hedging.

To further operationalise these findings, investors could implement a rule-based system for monitoring Solana. For example, if Solana shows significant price movements (above a predefined threshold), it may trigger a review or rebalancing of the Islamic equity portfolio, particularly in sectors aligned with Solana's growth, such as technology. Similarly, a lack of significant causality with other cryptocurrencies can lead investors to deprioritise them in diversification strategies. Portfolio managers should also account for the time-varying nature of these relationships and incorporate robustness checks when making strategic adjustments, as the relationship between cryptocurrencies and Islamic equities may shift during different market regimes or under varying macroeconomic conditions.

While this study provides robust evidence using a rigorous methodology, it is not without limitations. First, the relationships identified in this study are subject to time-varying effects, structural breaks, and sensitivity to lag selection, which could influence their stability across different market conditions. Therefore, investors and policymakers should apply these insights with caution, regularly reviewing the market dynamics and adjusting their strategies as needed. Second, the Toda-Yamamoto test is designed to capture linear Granger causality. Given the well-documented nonlinearity and volatility clustering in cryptocurrency returns, future research could employ non-linear causality tests or GARCH-family models to explore more complex dynamic relationships. Third, our analysis is conducted in a bivariate framework between each cryptocurrency and the Islamic index. A multivariate framework incorporating control variables (e.g., global market volatility, interest rates) could provide a more nuanced understanding. Furthermore, the study acknowledges the time-varying nature of crypto–equity interactions, sensitivity to lag selection, and the possibility of structural breaks. These factors suggest that the causality observed may not hold across all market conditions or time periods. Future research could extend this study's framework with rolling-window or time-varying causality tests to assess how crypto–Islamic linkages evolve across regimes. These avenues also present exciting opportunities for further scholarly works to explore non-linear or distribution-free causality techniques, such as the Diks and Panchenko (2006) non-parametric test, or regime-switching frameworks, to evaluate whether the causal relationships identified here remain stable across different volatility regimes or structural phases of the crypto market. Also, future studies could examine whether other emerging tokens with strong utility structures (e.g., Avalanche and Cardano) exhibit similar causal behaviour across different market regimes.

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